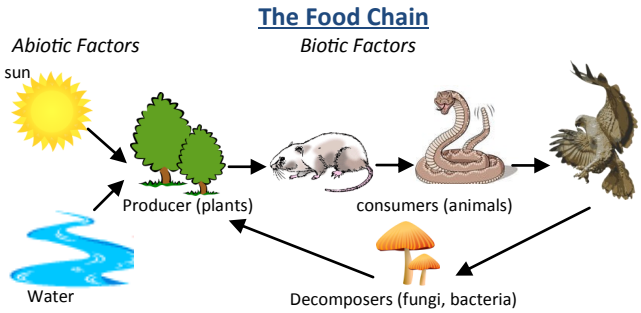
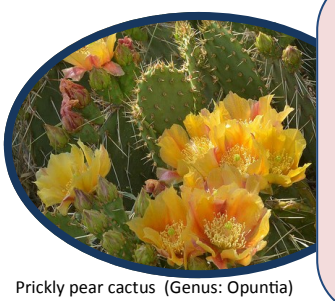
Grand Canyon Ecosystems

What comprises an Ecosystem? 'Eco' originates from the Greek word "oikos" meaning household. An **ecosystem** includes all the living things in a given area, like in a household, and all of the nonliving things they rely on. Ecologists refer to the living and non living parts as abiotic and biotic factors. **Abiotic** factors are all the non-living parts of the ecosystem like rocks, the sun, water and more. The **biotic** factors are the living parts; the plants and animals in that given area. The biotic factors can also be broken down into three groups: producers, consumers, and decomposers.

Producers are things like plants that create energy from abiotic factors like water, minerals, and the sun. **Consumers** are the animals that eat the producers. **Decomposers** are things like mushrooms, other **fungi,** and bacteria that break down dead plants and animals recycling their nutrients back into the ecosystem. Ecologists study the biotic and abiotic factors of an ecosystem to learn how organisms interact with other organisms and with the non living parts of their household.





Prickly pear cactus (Genus: Opuntia)

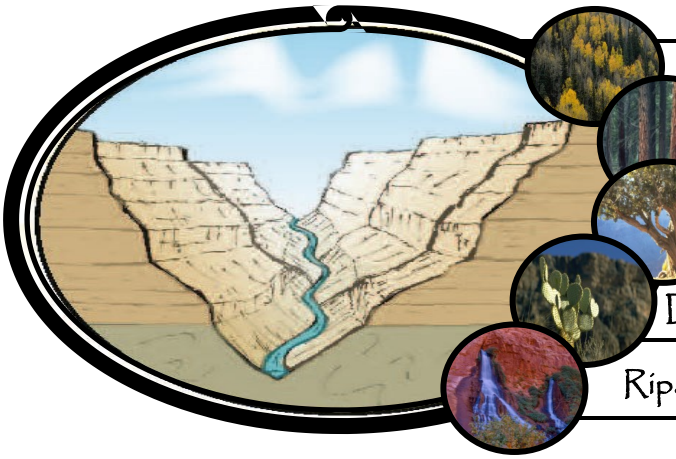
Animals and plants that live in an ecosystem have adaptations to live there. An **adaptation** is a physical characteristic or behavior that make them better at survival in their ecosystem. What adaptations does this cactus have to defend itself?

From rim to river...

Grand Canyon National Park has five major ecosystems. If you hike from the highest point on the North Rim to the Colorado River, you will see ecosystems that can be found from Canada to Mexico.

What makes these ecosystems so different from each other?

Elevation is the height of a given area above **sea level,** which is the level of the ocean surface often used as zero for measuring the height of things like mountains. **Precipitation** is the amount of rain, snow, sleet, or hail that falls onto the ground. Both *precipitation* and *elevation* influence where plants and animals can survive.



Let's explore these places!	Elevation (feet)
Mixed Conifer Forest	8,200—9,200
Ponderosa Pine Forest	7,000—8,200
Pinyon-Juniper Woodlands	4,000—7,300
Desert Scrub	1,200—4,500
Riparian	Not Elevation Dependent

Mixed Conifer Forest

Bald eagle (Haliaeetus leucocephalus)

Grove of aspen trees (Populus tremuloides)

The mixed conifer forest ecosystem is found at Grand Canyon only on the North Rim. It is between 9,200 to 8,200 feet in elevation. Intense storms blow through the North Rim's thick, shaded forests of tall evergreens like the Engelmann spruce and Douglas fir. Small aspen groves rise amongst the conifers. Autumn arrives as the leaves of the **deciduous** quaking aspen tree turn yellow and tremble in a golden shimmer before falling to cover the forest floor. This ecosystem receives about 25 inches of rain, more than any other canyon ecosystem. On average, 11 feet of snow falls on the North Rim.

When you look at a grove of aspen trees, like the picture above, you're often actually looking at just one tree! Aspen's roots send up stalks that will grow clones of the tree. This adaptation allows aspen to grow fast into areas cleared out by fire.

Adaptations

Using scientific reasoning, draw or list the adaptations apex predators have evolved with to allow them to survive and reproduce.

A long tail disappearing behind a tree may be a glimpse of a mountain lion, an athletic, ambush hunter and the apex predator in this ecosystem. An **apex predator** is a species that is at the top of the food chain. This means that although it still hunts and eats other animals, nothing else eats it. Mountain lions, like many predators, are **carnivores** which means they only eat meat.

Mountain lion (Puma concolor)

Apex predators help to keep an ecosystem in balance through hunting. In the 1900's we killed predators, like the mountain lion, at Grand Canyon in large numbers. The deer population grew in numbers since nothing was hunting them. Deer then ate all the available plants and in the winter of 1924-1925 thousands of deer starved to death. We've since learned important lessons about the value of predators in the ecosystem and how they keep prey populations in balance.

Snow melting on the North Rim

A Canyon Connected: Water Cycles

As spring arrives, melting snow creates ponds in the open meadows between the forest. Much of the snow melt passes through **sinkholes** and travels underground, emerging in the canyon as springs. A **spring** is a natural place where water flows out of the ground.

Roaring Springs

Ponderosa Pine Forest

The ponderosa pine forest ecosystem is found on the North and South Rims of Grand Canyon between 8,200 to 7,000 feet in elevation. It receives about 15 inches of rain every year and 5 feet of snow each winter. During the summer, regular thunderstorms arrive with a bang as lightning strikes trees on the rim. These routine summer storms are known as monsoons. They bring torrential but brief bursts of rain that often collect in washes rushing downstream creating flash floods.

Ponderosa pine (Pinus ponderosa) with holes from hungry birds

Ponderosa pine, the tallest tee of this ecosystem rising over 125 feet tall, and hill lupine are the most common plants in this ecosystem. During an intense thunderstorm, lightning may strike a ponderosa pine causing a wildfire. Wildfire caused by lightning is a natural part of life in this ecosystem.

Connect with Neighbors

The Kaibab squirrel is endemic to Grand Canyon. **Endemic** means this species can only be found in one geographic area. For the Kaibab squirrel this place is the ponderosa forest on the North Rim.

Kaibab squirrel (Sciurus aberti kaibabensis)

This squirrel relies on the ponderosa pine for food, munching on its cones, buds, and twigs. It also eats fungi that grow around the roots of the tree. Like a sponge the fungi help to keep moisture in the roots of the tree.

When the squirrel later **defecates,** it spreads the spores of the fungus allowing it to grow elsewhere. Relationships like these, where other species live with and rely on each other, is called **symbiotic.** The squirrel gets a meal, the fungus is spread, and the pine gets more water. Because everyone benefits in this situation it's a **mutualistic,** symbiotic relationship.

Red-naped sapsucker (Sphyrapicus nuchalis)

Sapsuckers create rows of holes in ponderosa pine trees that fill with sap that attract bugs. Bugs become stuck in the sap and then become the next meal for these birds.

Sketch a model of how you rely on other species for survival that also includes abiotic factors like the sun.

Kaibab squirrel (Sciurus aberti kaibabensis)

Pinyon- Juniper Woodland

Utah juniper (Juniperus osteosperma)

The pinyon-juniper woodland ecosystem is found in sunny locations on the North and South Rims of Grand Canyon between 7,300 feet to 4,000 feet in elevation. The pinyon-juniper woodland averages 7-14 inches of rain each year, including 5 feet of snow.

The pinyon pine and Utah juniper are the dominant plants found in this woodland environment. These **drought** resistant trees have needles or scaly leaves that have adapted to long periods without rain. Juniper trees can cut off water to branches in times of drought and survive by sacrificing a limb. Within the canyon, these trees provide shade when temperatures reach over 90°F.

Javelina (Tayassuidae) feeding on prickly pear cactus

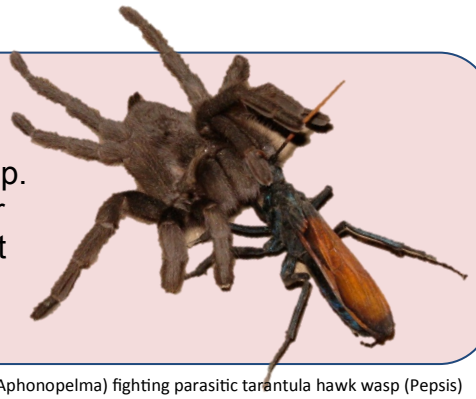
One of the strangest animals that calls this ecosystem home is the javelina. Javelina are **herbivores** meaning they only eats plants. These creatures have evolved to make a meal of prickly pear cacti, munching through the protective spines of the cacti.

Spotted Skunk (Spilogale gracilis) on the prowl

The spotted skunk also calls this ecosystem home. It's an **omnivore** and eats both meat and plants like us. The spotted skunk's diet is mostly berries, nuts, and small rodents. For creatures that live in this ecosystem and the desert scrub it's good to be adapted to eat a variety of different things because you never know when your next meal will be.

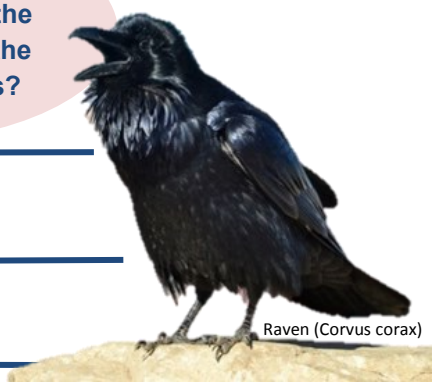
Painful Relationships

Tarantulas have a deadly relationship with the tarantula hawk wasp. The wasp stings and paralyzes the tarantula so that it can lay their eggs inside the spiders abdomen. When the larvae hatch, they eat the spider from the inside out. This is a **parasitic** relationship in which one species benefits at the expense of the other.



Tarantula (Aphonopelma) fighting parasitic tarantula hawk wasp (Pepsis)

How might physical characteristics, like the amount rain, affect the evolution of species?



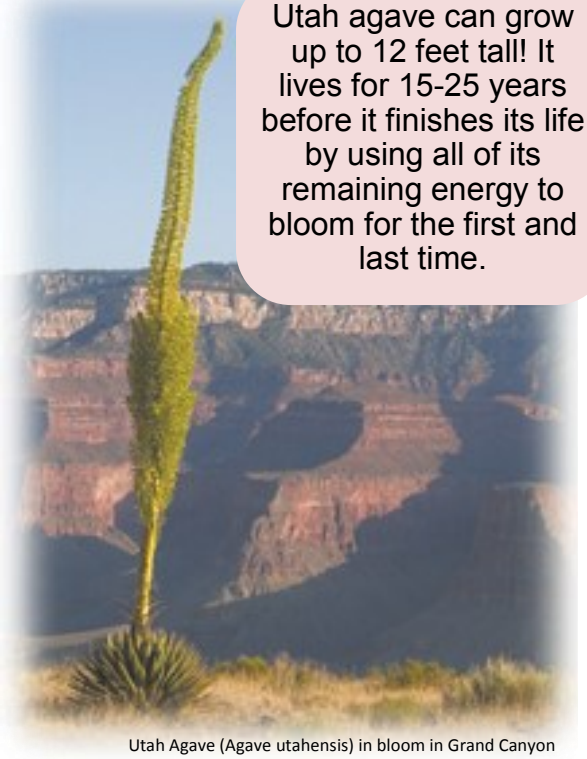
Raven (Corvus corax)

Desert Scrub

Desert bighorn sheep (Ovis canadensis nelsoni)

The desert scrub ecosystem is found at the lowest elevations in Grand Canyon, ranging between 4,500 feet down to 1,200 feet in elevation. One of the hottest, driest ecosystems at Grand Canyon, the desert scrub ecosystem only receives 7 inches of rain each year. Rain falling on higher ecosystems often evaporates before reaching this dry world. During the summer months, temperatures in the desert scrub can reach over 120ºF in the shade!

Unpredictable rainfall and lack of permanent water requires creatures to adapt to extreme dry conditions. The dominant plants in this ecosystem are blackbrush, sage, and prickly pear cactus. Like all of the life in this ecosystem, they have to be experts in water conservation.



Utah Agave (Agave utahensis) in bloom in Grand Canyon

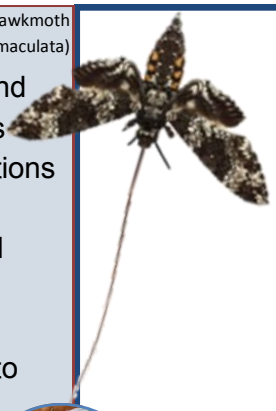
Utah agave can grow up to 12 feet tall! It lives for 15-25 years before it finishes its life by using all of its remaining energy to bloom for the first and last time.

This is also the home to many of the canyon's reptiles like the collared lizard. Being cold blooded creatures they can't control their body temperature internally like mammals. Reptiles rely on abiotic factors like the sun and shade from rocky crevices and plants to control their body temperature. Much of the life in this environment is **crepuscular** which means they are most active around sunrise and sunset. This allows them to have some light to see but also avoid the oppressive heat during the middle of the day.

Collared lizard (Crotaphytus collaris)

Adapted to Each Other

Five-spotted hawkmoth (Manduca quinquemaculata)



The sacred datura and hawk moth are two of Grand Canyon's nocturnal inhabitants. **Nocturnal** means they are active mostly at night. One of the adaptations the datura has to survive is that the entire plant is poisonous. The moth has adapted with the sacred datura to ingest the plant's poison. The caterpillar takes on the poisonous qualities of the plant for protection from predation. The moth has evolved to have a 14 inch long **proboscis**, or tongue, that helps to pollinate the datura. This makes the hawk moth one of the few insects that can pollinate the sacred datura. This is an example of **coevolution**, through generations of relying on each other, they have adaptations that are unique to each others' needs.

Sacred datura (Datura wrightii)

Sketch a relationship that you have with another species. How have humans affected that species' evolution?

Riparian

Little Colorado River in Grand Canyon

The riparian ecosystem is different from all the other ecosystems at Grand Canyon in that it is not dependent on elevation or precipitation. Riparian ecosystems are found anywhere there is a permanent, year-round water source such as creeks, springs, or ponds. At Grand Canyon, the Colorado River provides for the largest riparian ecosystem. Snow melting on the rims will enter the water table and travel underground for some time, maybe even years, until it emerges as springs in the canyon. **Springs** are natural places where water flows out of the ground.

Elves Chasm is one of the canyon's spring fed waterfalls

Although the riparian zones make up the smallest ecosystem at Grand Canyon, the riparian ecosystem supports the greatest biodiversity. **Biodiversity** is the variety of different animal and plant species that call an ecosystem home. A lot of biodiversity means a lot of different species. Some animals, like the canyon tree frog, can only be found near water. Others, like the big horn sheep, prefer other ecosystems but will still travel to the riparian areas for a drink of water.

Colorado River in Grand Canyon

Water is Life

Springs only make up 0.01% of Grand Canyon but contain more species than any of the other ecosystems. Biodiversity flourishes when these basic needs of life are provided for:

water, food, shelter, and space.

Canyon Tree Frog
(Hyla arenicolor)

The Colorado River's influence on Grand Canyon can be seen everywhere. It is what carved the canyon over millions of years and sustains the largest abundance of aquatic life. The waters of this river are also home to a handful of fish species including a few **endangered** species like the **endemic** humpback chub. Fisheries biologists have done a lot to help fish like the chub survive.

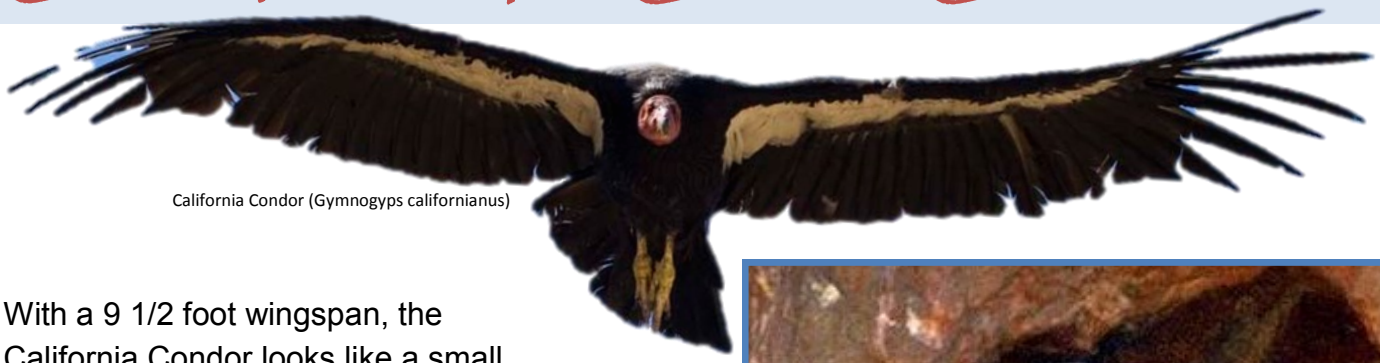
Humpback chub (Gila cypha)

Grand Canyon's residents and 5 million annual visitors rely on Roaring Springs (pictured left) in the canyon for all of their water.

Do you know where your drinking water comes from? If you don't know, ask a teacher or research it on the web.

Write or draw a picture below of where your water comes from in nature.

Creature Feature: The California Condor



California Condor (Gymnogyps californianus)

With a 9 1/2 foot wingspan, the California Condor looks like a small plane soaring over the canyon rim. This giant of the skies is the largest flying land bird in North America. The condor is also one of the rarest birds in the world, and is listed on the world's endangered species list. An **endangered** species is an animal or plant that's close to going extinct. Going **extinct** would mean that there are no longer any living members of that species left.

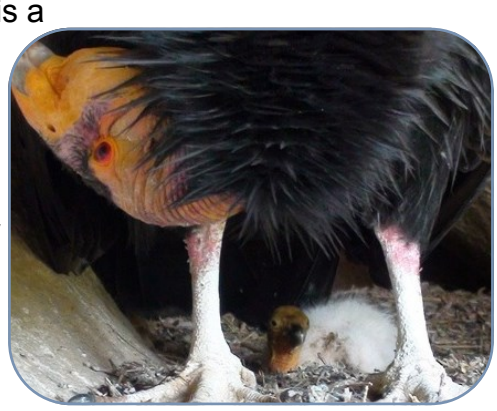
Condor in a cave nest

Condors make their homes inside caves that are high up in Grand Canyon cliffs.

Condors are **scavengers** so they rely on dead animals, or carrion, for food. They help to clean up the natural world by eating the remains of dead animals. This helps by recycling the nutrients found in carrion back through the food chain to the producers.

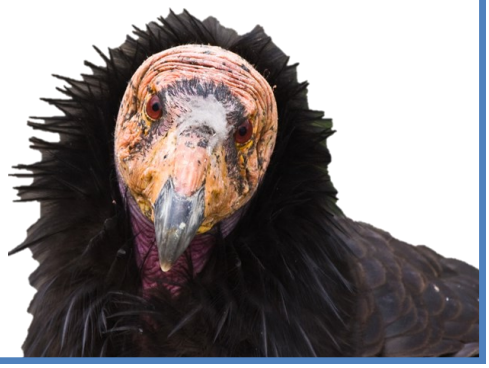
In 1982 only 22 California Condors were left on the planet. Why were there only 22? Lead poisoning has been one of the main reasons for their decline. Sometimes the carrion the birds find has been shot by lead ammunition which poisons the feeding condor. Many people including scientists, park rangers, and passionate citizens decided to take action to save the condors. Because this group of people took action, over 400 condors exist today, 80 of which are flying free in Grand Canyon skies.

Our national park is a sanctuary for these rare birds, where they are protected and monitored for their safety for generations to come.



Condor chick with parent

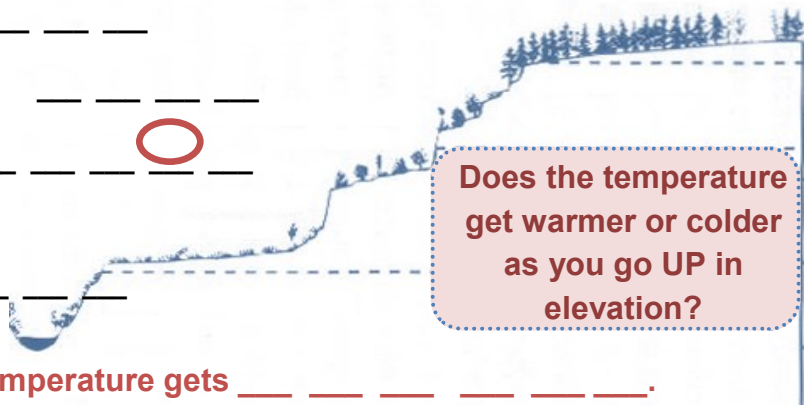
How might our growing human population and its needs affect endangered species like the California condor?



Grand Levels of Change

Please complete the following activities before your lesson with Grand Canyon park rangers.
Label the ecosystems in the order you would find them when hiking from the North Rim to the Colorado River.
Unscramble the circled letters to answer the question at the bottom.

1. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
2. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
3. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
4. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
5. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

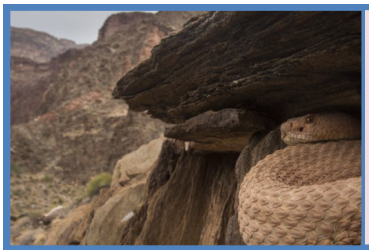


The temperature gets _ _ _ _ _ _.

Ecosystem Comparison

Practice being a **naturalist** by exploring your backyard with your class.
Compare your home environment to one of the five ecosystems at Grand Canyon.
This section can be used for your group presentation with Grand Canyon park rangers

	My Home: _____	My Grand Canyon Ecosystem: _____
Elevation		
Precipitation		
Two plants	_____ _____	_____ _____
Two animals	_____ _____	_____ _____
How do the abiotic factors affect the populations and growth of organisms in each ecosystem?		



Grand Canyon's Biotic Community

Grand Canyon National Park is one of the most biologically diverse places in America and is home to….

Plants: >1,750 species **Fish:** 18 species
Mammals: 92 species **Amphibians & Reptiles:** 57 species
Birds: 373 species **Insects:** 8,480 discovered species

Endemic Grand Canyon rattlesnake (Crotalus oreganus abyssus)

Vocabulary

Abiotic: the non-living parts of an ecosystem (examples: sun, rocks, water).

Adaptations: a physical characteristic or behavior of an animal or plant that allow them to live in a particular place after generations of surviving and living in that ecosystem.

Apex Predator: a predator at the top of the food chain which means they typically are not preyed upon by any other animals (examples: mountain lions, wolves).

Biodiversity: the variety of different plant and animal species in an ecosystem.

Biotic: the living parts of an ecosystem (examples: plants, fungi, and animals).

Carnivore: an animal whose diet consists only of meat from other animals (example: mountain lions).

Coevolution: when two or more species living together in an ecosystem evolve in ways that are complimentary to each other (example: bumblebees and flowers).

Consumer: an organism that gets energy by eating other organisms, such as a deer eating grass.

Crepuscular: a creature that is most active around sunset and sunrise (example: firefly).

Deciduous: type of trees or shrubs that go through the natural process of seasonal leaf loss, like oak trees.

Decomposer: an organism that breaks down dead matter recycling it back into the soil for plants to use.

Defecate: the act of discharging solid waste from an animal's digestive system.

Drought: a period of below-average precipitation that can last days, months, or even years.

Elevation: the height of a particular region above a defined base height, which is often sea level.

Endangered: a species who's population is critically near extinction.

Endemic: a species is a native of a region, found nowhere else in the world.

Ecosystem: all of the living and non-living factors that rely on each other in a geographic region.

Evaporate: the process by which a liquid becomes a gas; most often done through heating the liquid.

Extinct: When a species no longer has any living members left.

Fungus (plural: Fungi): the name for the kingdom of decomposers (examples: mushrooms, mold).

Herbivore: an animal that eats only plant matter (example: deer

Mutualism: a symbiotic relationship that is beneficial to both organisms.

Naturalist: an expert in the natural sciences such as scientists and park rangers.

Nocturnal: creatures that are most active at night (example: owls).

Omnivore: a species that consumes plant matter and meat from other animals (example: skunks, humans).

Parasitism: a symbiotic relationship in which one species benefits and another species is disadvantaged or even hurt because of the relationship (example: ticks, lice).

Precipitation: forms of water falling from the sky, such as rain, hail, and snow.

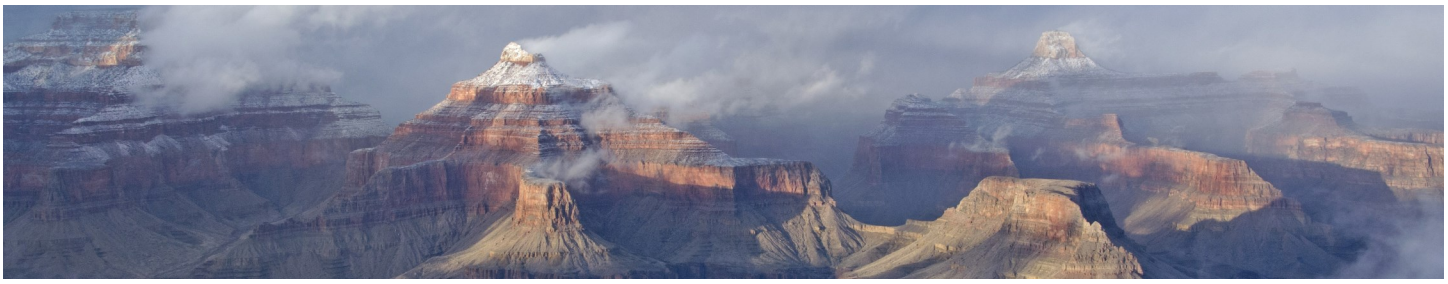
Proboscis: an extending mouthpart that is typically a flexible tube used to eat and drink (example: butterfly)

Producer: an organism that serves as a food source for others in the food chain (example: plants).

Sea level: the level of the surface of the ocean. When we base elevation on this level, sea level is zero and all the elevations above it are calculated from there.

Sinkhole: a hole in the ground formed when cavities under the surface collapse allowing water to pass into underground cavities (examples: caves, faults).

Symbiosis: the interaction between two species that live together within an ecosystem.



Get a Closer Look: Additional Resources

Students identifying plants in the desert scrub ecosystem

To learn more about everything found in this booklet feel free to browse the following links…

General

General science page: http://www.nps.gov/grca/learn/nature/index.htm
Ecosystems: http://www.nps.gov/grca/learn/nature/naturalfeaturesandecosystems.htm
Animals: http://www.nps.gov/grca/learn/nature/wildlife.htm
Plants: http://www.nps.gov/grca/learn/nature/plants.htm
Springs: http://www.nps.gov/grca/learn/nature/springs.htm
Wildfire: http://www.nps.gov/grca/learn/nature/fireregime.htm
Fire management: http://www.nps.gov/grca/learn/management/firemanagement.htm

Threats to Grand Canyon

Nonnative species: http://www.nps.gov/grca/learn/nature/nonnativespecies.htm
Dams on the Colorado River: http://www.gcdamp.gov/index.html

Endangered Species

Grand Canyon's California condors: http://www.nps.gov/grca/learn/nature/california-condors.htm
Condor rescue efforts: http://www.peregrinefund.org/condor
Native fish (humpback chub): http://www.nps.gov/grca/learn/nature/fish.htm
Humpback chub rescue efforts: http://www.nps.gov/grca/learn/nature/shinumotransloc.htm

Other

Photos and videos: http://www.nps.gov/grca/learn/photosmultimedia/index.htm
YouTube (username: GrandCanyonNPS): www.youtube.com/channel/UC8jf0seie_pM_rsPp27aBgA
Ecology for kids: http://www.nps.gov/grca/learn/kidsyouth/upload/Ecology_Final_5-21-13_smaller.pdf
Scientific research: http://www.gcmrc.gov/research_areas/research_areas_default.aspx